Case History

How additional data can improve your perspective

"...Without the gap voltage data we might have assumed the problem was much worse .... and taken unnecessary, time-consuming precautions..."

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Diagnosing machine problems can be difficult if you lack sufficient data to reach a well-thought-out and reliable conclusion. Often you are uncertain whether you are addressing a symptom or a more basic and underlying problem. We would probably all agree, the more data one has, the better or more accurate conclusion one can attain. However, certain types of data are more valuable than others.

The perspective that data provides can be a key characteristic that allows one to bring a situation into clear view. It can define the boundaries of a potential problem and enable key decision-makers to implement well-defined plans for correcting it and returning the machine to service. Key decision-makers at Pennsylvania Electric Company experienced these thoughts at their Homer City Generating Station when diagnosing a turbine generator bearing problem.

Sometimes, acknowledging the existence of a problem, reviewing the plant's computer data and recreating the sequence of events doesn't provide enough information to generate reliable and well-defined conclusions about a problem. In Homer City's case, one more type of data from their vibration monitoring system defined their perspective. With that last bit of information, plant and headquarters personnel decided they knew what the machine problem was. Having reached that decision early in their effort, they were able to quickly and confidently plan a required outage.

Sequence of events

Homer City Station's Unit #2 is a 600 MW Westinghouse tandem unit with 11 bearings. The unit's vibration monitoring system uses both proximity and casing-mounted transducers. More importantly, and key to Pennsylvania Electric's success in this instance, each bearing is fitted with transducers in an XY configuration. A Bently Nevada Dynamic Data Manager® (DDM) System continually acquires and processes data from the monitoring system.

After coming back on-line from an outage late in 1991, Unit #2 tripped off-line on 10 January 1992, due to a boiler flame scanner system failure. The unit coastdown didn't seem out of the ordinary. Later review of computer data did reveal babbitt temperature spikes in the No. 6 bearing, the main bearing located on the generator side of the LP "A" casing. The flame scanner problem was►

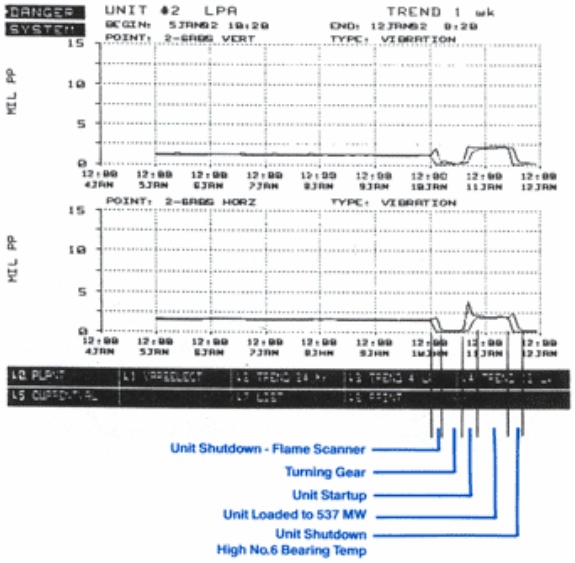

Figure 1A & 1B

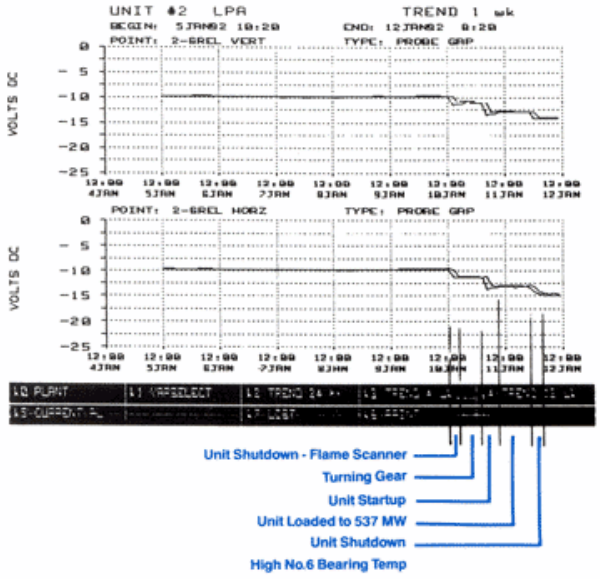

Figure 2A & 2B

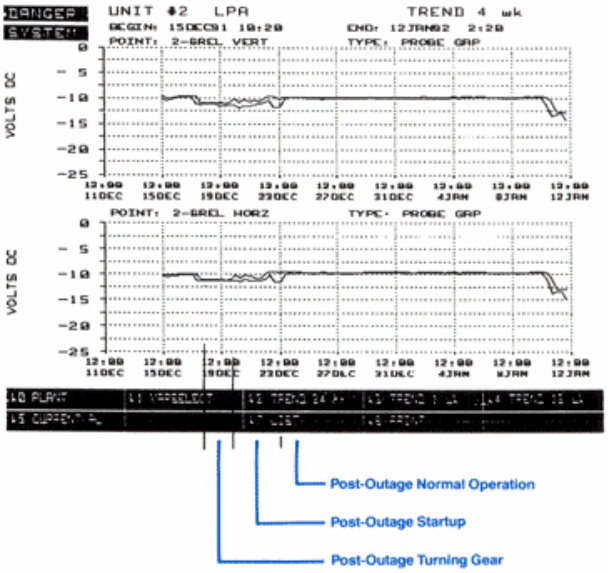

Figure 3A & 3B

corrected, and the unit was brought up to synchronous speed. The operators took normal precautions checking the bearing temperatures. They were also sensitive to the fact that bearings 5, 6, 7 and 8 were changed from sleeve type to tilt-pad type bearings during a previous outage and tended to run hotter.

During the run-up, temperature excursions within the No. 6 bearing spiked as high as 250°F (121°C) but settled at just under 200°F (93°C). The electrical integrity of the thermocouple in the No. 6 bearing was checked and was thought to have caused the spikes. The operators then started loading the unit. The No. 6 bearing temperature steadily increased to 237°F (114°C). Adjacent bearing temperatures were elevated but not to the extent of bearing No. 6. At 537 gross MW output, the operators decided a potentially-severe problem existed. They subsequently unloaded the unit and tripped it off-line. The unit was placed on turning gear. The operators wisely concluded the unit should come off-line, but they did not know what the problem was or its severity.

The problem - A case of perspective

Carl Krejdovsky, the headquarters' Senior Technical Supervisor assigned to Homer City Station, was quickly called for assistance. Carl reviewed turbine operating data, starting with data from a previous startup, and then focusing on data from the prior two days. His review included rolldown time, turbine metal temperatures, bearing metal temperatures and vibration data recorded on the DDM. At the same time, certain inspection procedures were implemented on the turbine generator.

He reviewed the No. 6 bearing's temperature excursions as he wanted to be confident it was the only bearing with a problem. Roll-up and coastdown vibration data indicated levels no higher than 3 to 3.5 mils, which were acceptable levels. Figures 1A and 1B illustrate a trend of the horizontal and vertical probe vibration levels at the No. 6 bearing. Krejdovsky remarked, "I knew we had a problem, and I knew bearing No. 6 was the likely candidate. I didn't know how severe the problem was, and from my viewpoint, it was possible a bad thermocouple was leading us astray."

Inspection of the lube oil strainers revealed evidence of bearing material, but configuration of the lube oil system didn't allow further pinpointing of the bearing or bearings that were damaged, if any were wiped at all. Although Carl thought it was unlikely, it was possible that the problem was only a wiped edge. Similarly, the metal flakes in the strainers could have come from an unrelated problem that hadn't yet become visible!

Carl examined Trend gap voltage data from the No. 6 bearing horizontal and vertical probes, as well as that of probes of adjacent bearings, from steady state operation prior to the flame scanner system failure, through the shutdown, and the subsequent startup and second shutdown. The probe gap voltage data supplies information about the static position of the journal inside the bearing clearance. During the shutdowns and startups, the gap voltage of both probes on bearing No. 6 became more negative (Figures 2A & 2B). The No. 6 bearing was progressively wiping during each roll-up and coastdown, causing the rotor journal to drop step-by-step in the bearing. A review of the gap voltage values just after the previous outage (Figures 3A and 3B) confirmed the rotor had fallen below the -11.0 to -11.5 Vdc normal turning gear values. Krejdovsky concluded, "The gap voltage information defined the severity of the problem ... I now knew it was a very real and severe problem."

Review of gap voltage data from the adjacent bearings revealed little or no changes from nominal. Krejdovsky added, "No. 6 bearing was the problem,

without a doubt. Of course, all other bearings, from #1 through #11 were also disassembled, inspected and cleaned. Without the gap voltage data, we might have assumed the problem was much worse .... and taken unnecessary, time-consuming precautions." Having now comfortably determined the problem, Carl was able to recommend actions to Homer City's management for timely repair of the unit. Ronald Lantzy, Homer City's Station Director, acknowledged, "the gap voltage data provided us an immediate, critical perspective of the problem." With that perspective, plant personnel and Carl Krejdovsky knew the scope of work necessary to get Unit #2 back on-line.

When bearing No.6 was disassembled, an oil bore check revealed the rotor in the bearing was 20.5 mils lower than it was during original assembly. The XY proximity probe gap voltage readings combined to indicate the rotor had dropped 20 mils in the bearing. Bearing No. 5 had slight damage that was easily polished out. Before returning the unit to service, a high velocity oil flush and turbine lube oil cooler cleaning were also performed.

Conclusions

Homer City is now keeping records of gap voltages for all bearings before and after unit outages. Recording them will allow the station to historically compare rotor position in every bearing, providing factual insight on the condition of the bearings.

A proximity probe transducer provides a gap voltage measurement along with the shaft relative vibration that is typically displayed to operators. It's there; one only needs to use it. Use of XY probes on a bearing can define the position of a rotor within the bearing along with two direction vibration information. When attempting to decide the extent of problems, a history of previous gap measurements before and after the incident can give you a sense of perspective. Gap voltage readings are important and informative. They shouldn't be ignored. ■